

Original article

Association between types of play materials and cognitive development among 12-month-old Thai infants: the prospective cohort study of Thai children

Kaewjai Thepsuthammarat^a, Bandit Thinkhamrop^b, Chanpen Choprapawon^c

^aGraduate School, Khon Kaen University, ^bDepartment of Biostatistics and Demography, Faculty of Public Health, Khon Kaen University, Khon Kaen 40002, ^cThailand Research Association for Child and Family Development (TRAC), Bangkok 10250, Thailand

Background: Cognitive development is one of the most important aspects of child development. Stimulation is essential, especially for children between 1 and 2 years of age. Play materials is one realm where choice is relatively limited.

Objective: We investigated the relationships between play materials and cognitive ability.

Methods: This large, prospective, community-based cohort study, in the four regions and the capital of Thailand, studied the relationships between toys and cognitive ability in 4,116 children when they reached the first year of life. Details of play toys were collected at home and cognitive scores were measured using the Capute scale two weeks later. Multivariable analysis incorporated the following variables in the final multiple regression model, the 12 types of play materials, study center, parent factors (i.e., age, education, marital status, and income), and child factors (i.e., sex, weight, height, gestational age, birth weight, breastfed, hospital admission, mother-child attachment, number of members in family, number of sibling, iodine consumption, and life events).

Results: The first three common materials played with at home included push/pull toys (75.3%), home utensils (75.0%), and sound-making toys (73.9%). Adjusted for the potential factors, five out of the 12 types of play materials were significantly associated with the Capute scale, viz., sound-making toys ($p = 0.029$), push/pull toys ($p = 0.003$), creative toys ($p = 0.003$), natural materials ($p = 0.002$), and storybooks ($p = 0.027$). Children who played with natural materials had a higher Capute score than those who did not, with the mean difference of 1.9 (95%CI: 0.7 to 3.1). This was followed by creative materials (mean difference = 1.8, 95%CI: 0.6 to 2.9), and push/pull toys (mean difference = 1.8, 95%CI: 0.6 to 3.0).

Conclusion: The results of the current study underscore the importance that natural materials, creative materials, and push/pull toys be available for children to play with during the first year of life.

Keywords: Capute scale, cognitive development, infant, play materials, toys

Child growth and development have received attention for decades [1]. Cognitive development, in particular, is one of the most important milestones of child development. A number of studies have revealed that cognitive development is influenced by many factors; such as, parent factors [1-3], infant factors [4-9], genetics and environments [10], supportive parenting [11], culture, family size [2, 5], iodine consumption, life events, and the number of siblings [12]. Most of these factors are difficult to assess so

attempting to isolate and manipulate them in order to achieve improved cognitive development is not realistic.

The nervous system is largely developed by the age of two years [13]. During this critical period, stimulation is an important process for cognitive development [14]. Choices of play materials or toys—that can be used to stimulate development in very young children—can be limited. In one study, toys were tested that would enable children with motor disabilities to play in order that their cognitive and social development would be enhanced [15]. Another study demonstrated that appropriate play materials influenced cognitive development in children between 20 and 40 months of age [2]. Similarly, a study

Correspondence to: Bandit Thinkhamrop, Department of Biostatistics and Demography, Faculty of Public Health, Khon Kaen University, Khon Kaen 40002, Thailand.
E-mail: karawa@gmail.com

suggested that provision of toys is associated with better child cognitive and language development [16].

The majority of recent studies investigating roles of play materials on child development have been conducted on children with special needs or developmental disabilities [17-21] and most involved a small sample size (as small as three) [20, 21] while studies with a larger sample size were mostly smaller than one hundred. These studies involved preschoolers or children older than one. To the best of our knowledge, there has been no study involving play materials among children in their first year of life.

In normal children, a longitudinal study demonstrated that availability of play materials in infancy was related to cognitive development at three years of age [22]. A study also found that children with access to a variety of play materials reached higher levels of intellectual achievement [23]. The types of play materials and how they are used is equally important [24]. There is evidence that the types of play materials influence children's responses [21]. The current study aimed to determine if the type of play materials for one-year-old children was indeed associated with their cognitive development.

Materials and methods

The study protocol has been approved by the Human Research Ethics Committee of Khon Kaen University, Thailand. This study is part of an observational, community-based, longitudinal study in Thailand called the Prospective Cohort Study of Thai Children (PCTC). The PCTC enrolled pregnant women—willing to participate in the study—from four rural districts (one district in each region including North, Northeast, South, and Central) and Bangkok (specifically, the catchment for Ramathibodi Hospital). Four thousand two hundred forty five children born between October 2000 and September 2002 were followed. Our component of the study involved 4,116 children whose type of play materials in their homes were recorded two weeks before the children reached 12 months old.

Primary outcome: cognitive development measurement

Cognitive development was measured using the Capute scale, developed to assess cognitive skills in children between 1 and 36 months of age. This was done by pediatricians who worked at hospitals, which were in the study areas of the PCTC. The doctors

were trained in the use of the Capute scale prior to the visit of the PCTC cohort members.

The cohort members were asked to visit the hospital at two weeks to one month after the home visit for play materials survey. The Capute scale consists of a Cognitive Adaptive Test (CAT) and Clinical Linguistic and Auditory Milestone Scales (CLAMS). The CAT is used to evaluate fine motor and problem solving skills while the CLAMS determine language skills. The Capute scale was found to be highly correlated with the Bayley Scales of Infant Development-Mental Scale (BSID) ($r = 0.89$; 95%CI: 0.83 to 0.93). It is the only cognitive development measurement available in the Thai language.

Study variable: type of play materials

The play materials survey was conducted using home visits. At the visit to each cohort member's home, the main caregivers were asked to bring all play materials, which were usually played with by the child. Then, the researchers listed the toys on record forms. Play materials were categorized and counted as per Chase's 12 types [25], which included: push/pull toys, home utensils, sound-making toys, junk materials, dolls and other soft toys, natural materials, storybooks, creative materials, writing materials, self-invented toys, stacking toys and musical cassettes.

Potential confounders

To obtain a valid estimate of the effect of play materials on cognitive development, potential confounders were accounted for in the analysis; including parent factors (i.e., age, education, marital status, socioeconomic level), and child factors (i.e., sex, gestational age, birth weight, breastfed, illness, weight and height at one year old, parent attachment, family size, number of siblings, iodine consumption, and life events).

The characteristics of the parents and iodine consumption were discovered at the enrolment interview. Income was assessed according to the parents' self-reporting (at their child's birth) and classified into three groups using the 25th and 75th percentiles as cut-off points. Gestational age, sex and birth weight were taken from the medical records unless the child was born at home. All other data were recorded when the researchers made home visits when the child reached one year old. Breast-feeding, hospitalization(s) during the previous 6 months, family size, number of siblings and life events were discovered

through the interview of the parents or caregivers. Each child's weight and height was measured directly when they visited the hospital in the next two weeks. Mothers' attachment was observed during the interview. Attachment measurements comprised five positive and three negative items, which were observed as the mother interacted with her child.

Data analysis

Each demographic characteristic was presented as a mean and a standard deviation (SD) for continuous variables and as a frequency and percentage for the categorical variables. The play materials found in each child's home were recorded along with a percentage of how much it was played with by type, and their 95% confidence intervals (CI). The effects of play materials on the Capute scale—being quantified by the mean difference of the Capute scale—which drew a comparison between children who played with and those who did not play with certain of the materials—were analyzed using simple linear regression. This comparison serves as an exploratory effect of each type of play material without adjustment for effects of other factors.

A univariate analysis for assessing the effects of selected factors on the Capute scale was also done, using simple linear regression. From these analyses, variables with $p < 0.25$ were included in the initial multiple regression model. From the final multiple linear regression model, the effect of each type of play material on the Capute scale was estimated. The magnitude of the effect was presented as the mean difference with its 95%CI adjusted for the effects of: other types of play materials, study center, parent factors (i.e., age, education, marital status, and income), child factors (i.e., sex, weight, height, gestational age, birth weight, breastfed, hospital admission, mother's attachment, family size, number of sibling, iodine consumption, and life events).

All analyses were done using Stata version 10 (StataCorp, College Station, TX). The significance level was set at 0.05 and all tests were two-sided.

Results

The PCTC enrolled 4,245 children from the four regions of Thailand (the North, the South, the Northeast, and the Central plain) as well as from Bangkok Metropolitan (**Table 1**). Information on the cognitive measurements and play materials were

available for 4,116 children. The children were born to mothers who on average were 27 ± 6 years of age and illiterate (or just had primary school education). There were an equal number of boys and girls, with a mean weight of $8,827 \pm 1,197$ g and mean length of 73.6 ± 3.5 cm. Most of the children had an average family size of 5 ± 2 with 1 ± 1 siblings. The group had 8.9% preterm infants, 8.6% with a low birth weight, 20.2% breastfed < 3 months and 10.0% hospitalized during the second half of their first year of life.

The most common materials being played with at home included push/pull toys (75.3%), home utensils (75.0%), and sound-making toys (73.9%) as can be seen in **Table 2**, followed by junk materials (69.7%) and dolls and other soft toys (68.6%). Children rarely played at home with self-invented toys (10.4%), stacking toys (9.9%), or musical cassettes (6.8%).

Compared with children who did not play, the Capute scale was significantly higher among children who played with push/pull toys ($p < 0.001$), home utensils ($p < 0.001$), junk materials ($p < 0.001$), dolls and other soft toys ($p < 0.001$), natural materials ($p < 0.001$), storybooks ($p = 0.038$), creative materials ($p < 0.001$), writing materials ($p < 0.001$), and stacking toys ($p = 0.023$) (**Table 3**). Among these, creative materials had the largest effects, with a mean difference of 5.4 (95%CI: 4.3 to 6.4), followed by natural materials (mean difference = 5.1, 95%CI: 4.0 to 6.1) and junk materials (mean difference = 4.1, 95%CI: 2.9 to 5.2). By contrast, children who played musical cassettes had a significantly lower Capute scale than those who did not ($p < 0.001$); however, these findings have not yet accounted for the effects of other factors.

The results of the univariate analysis revealed that children had a significantly higher Capute scale, with a considerably stronger effect, according to a mean difference of greater than two scores; if they were born to younger mothers ($p = 0.025$), born to less educated parents ($p = 0.002$), born to married parents ($p = 0.027$), were full gestational age ($p = 0.002$), had a birth weight of $> 2,500$ g ($p < 0.001$), had a longer duration of breastfeeding ($p < 0.001$), and had never been hospitalized during the second half of their first year of life ($p = 0.003$) (**Figures 1 and 2**). These factors were entered into the final regression model to account for their effects on the relationship between play materials and the Capute scale in the subsequent analyses.

Table 1. Characteristics of children and their parents

Characteristic	Number	Percent
Study area		
Central region	759	18.4
Southern region	1,061	25.8
Northeastern region	853	20.7
Northern region	772	18.8
Bangkok Metropolitan	671	16.3
Parent characteristics		
a) Mother's Age (Mean SD)	4,069	27.0 6.2
b) Mother's education		
Illiterate/ Primary school	2,149	53.0
Secondary school	1,157	28.5
Commercial college/ University	752	18.5
c) Father's education		
Illiterate/ Primary school	1,851	51.9
Secondary school	1,031	28.9
Commercial college/ University	688	19.3
d) Income		
Low	964	23.68
Middle	2,090	51.34
High	1,017	24.98
Children characteristics		
a) Sex		
Male	2,039	49.8
Female	2,059	50.2
b) Weight (Mean±SD)	4,074	8,827±1,196
c) Length (Mean±SD)	4,072	73.6±3.5
d) Family size (Mean±SD)	4,110	5±2
e) Siblings		
0	1,761	43.4
1	1,507	37.2
2	452	11.2
3+	334	8.2
f) Preterm (Gestational age <37 wks)	336	8.9
g) Low birth weight (<2,500 g)	340	8.6
h) Breast feeding (months)		
< 3	827	20.2
3-5	600	14.7
6+	2,669	65.2
i) Hospital admission last 6 months		
No	3,700	90.0
Yes	410	10.0

Table 2. Types of play materials found in the home

Type of play materials	Number of children	% having play materials	95% CI
Push/pull toys	4,113	75.3	74.0, 76.7
Home utensils	3,729	75.0	73.6, 76.4
Sound-making toys	4,115	73.9	72.5, 75.2
Junk materials	3,745	69.7	68.2, 71.2
Dolls and other soft toys	4,113	68.6	67.1, 70.0
Natural materials	3,703	49.3	47.7, 50.9
Storybooks	4,112	32.8	31.3, 34.2
Creative materials	4,111	31.3	29.9, 32.7
Writing materials	4,096	25.9	24.6, 27.3
Self-invented toys	4,105	10.4	9.4, 11.3
Stacking toys	4,106	9.9	9.0, 10.8
Musical cassettes	4,114	6.8	6.1, 7.6
Others	4,103	44.1	42.6, 45.6

Table 3. Univariate analysis for assessing the effects of play materials using the Capute scale

Types of toys	Number	Mean	SD	Mean difference	95% CI
Push/pull toys					
Played	2,942	116.9	15.7	2.0	0.8, 3.2
Did not play	920	114.9	15.9	0	-
Home utensil					
Played	2,635	117.9	15.5	2.0	0.8, 3.2
Did not play	850	115.9	16.1	0	-
Sound-making toys					
Played	2,867	116.6	15.9	0.5	-0.6, 1.7
Did not play	997	116.1	15.1	0	-
Junk materials					
Played	2,466	118.6	15.4	4.1	2.9, 5.2
Did not play	1,033	114.5	16.1	0	-
Dolls and other soft toys					
Played	2,657	117.3	15.9	2.6	1.5, 3.7
Did not play	1,205	114.7	15.2	0	-
Natural materials					
Played	1,730	120.0	14.0	5.1	4.0, 6.1
Did not play	1,729	114.9	16.9	0	-
Storybooks					
Played	1,258	117.3	15.7	1.1	0.1, 2.2
Did not play	2,603	116.1	15.7	0	-
Creative materials					
Played	1,233	120.2	14.9	5.4	4.3, 6.4
Did not play	2,627	114.8	15.8	0	-
Writing materials					
Played	993	118.3	15.5	2.5	1.3, 3.6
Did not play	2,852	115.8	15.7	0	-
Self-invented toys					
Played	409	117.6	14.7	1.2	-0.4, 2.8
Did not play	3,445	116.4	15.8	0	-
Stacking toys					
Played	380	118.2	16.1	1.9	0.3, 3.6
Did not play	3,475	116.3	15.7	0	-
Musical cassettes					
Played	260	110.1	16.7	0	-
Did not play	3,603	116.9	15.6	6.9	4.9, 8.8

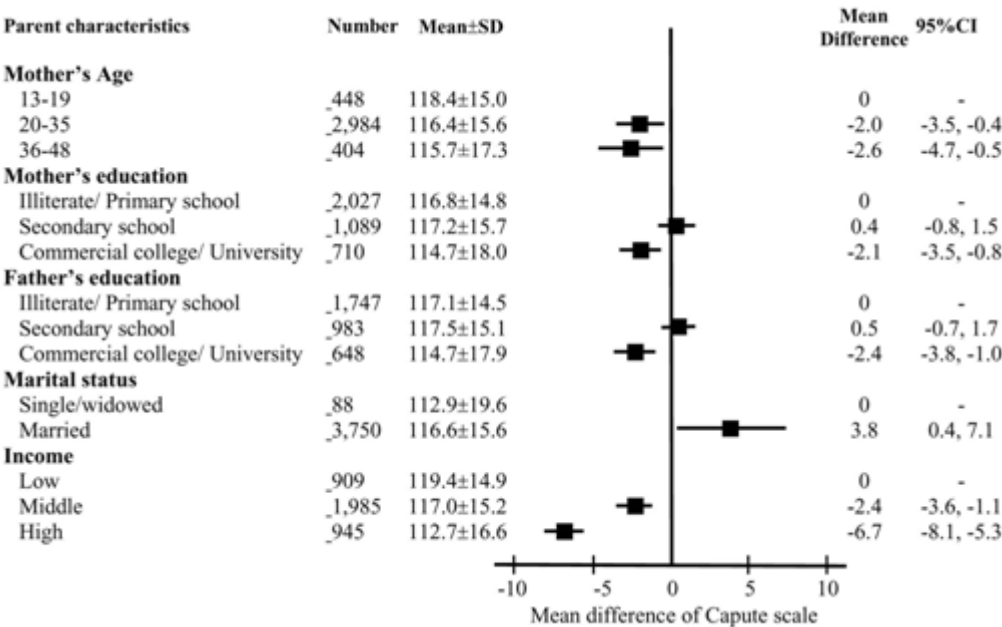


Figure 1. Univariate analyses for assessing the effects of parent factors on the Capute scale

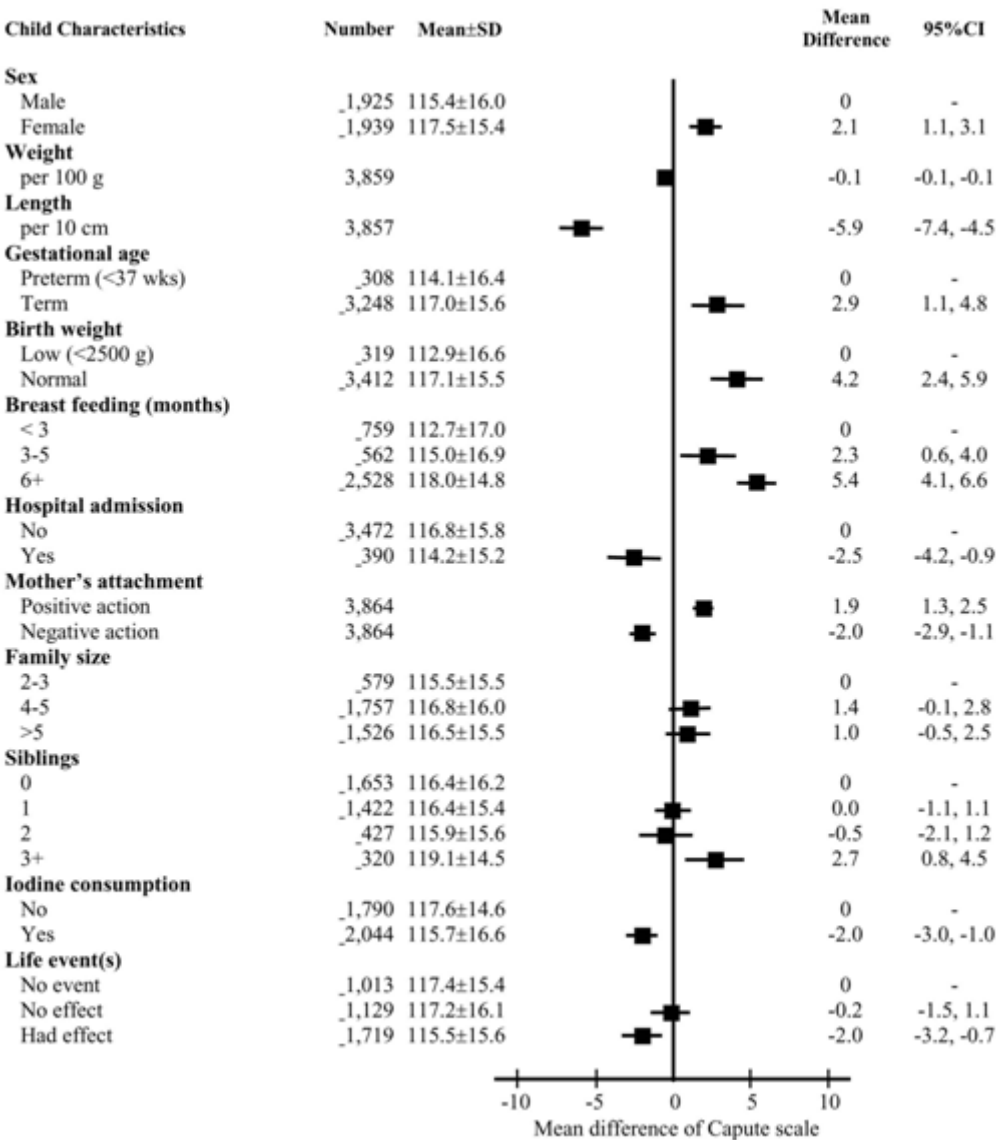


Figure 2. Univariate analyses for assessing the effects of child factors on the Capute scale

The multivariable analysis incorporated the following variables in the final multiple regression model (a) the 12 types of play materials (b) study center (c) parent factors, and (d) child factors. Five of the 12 types of play materials were significantly associated with the Capute scale; namely, the push/pull toys ($p = 0.003$), sound-making toys ($p = 0.029$), natural materials ($p = 0.002$), storybooks ($p = 0.027$),

and creative materials ($p = 0.003$) as shown in **Figure 3**. Play materials that had the strongest effect on the Capute scale—i.e., children who played had higher scores than who did not—was natural materials, with a mean difference of 1.9 (95%CI: 0.7 to 3.1), followed by creative materials (mean difference = 1.8, 95%CI: 0.6 to 2.9), and push/pull toys (mean difference = 1.8, 95%CI: 0.6 to 3.0).

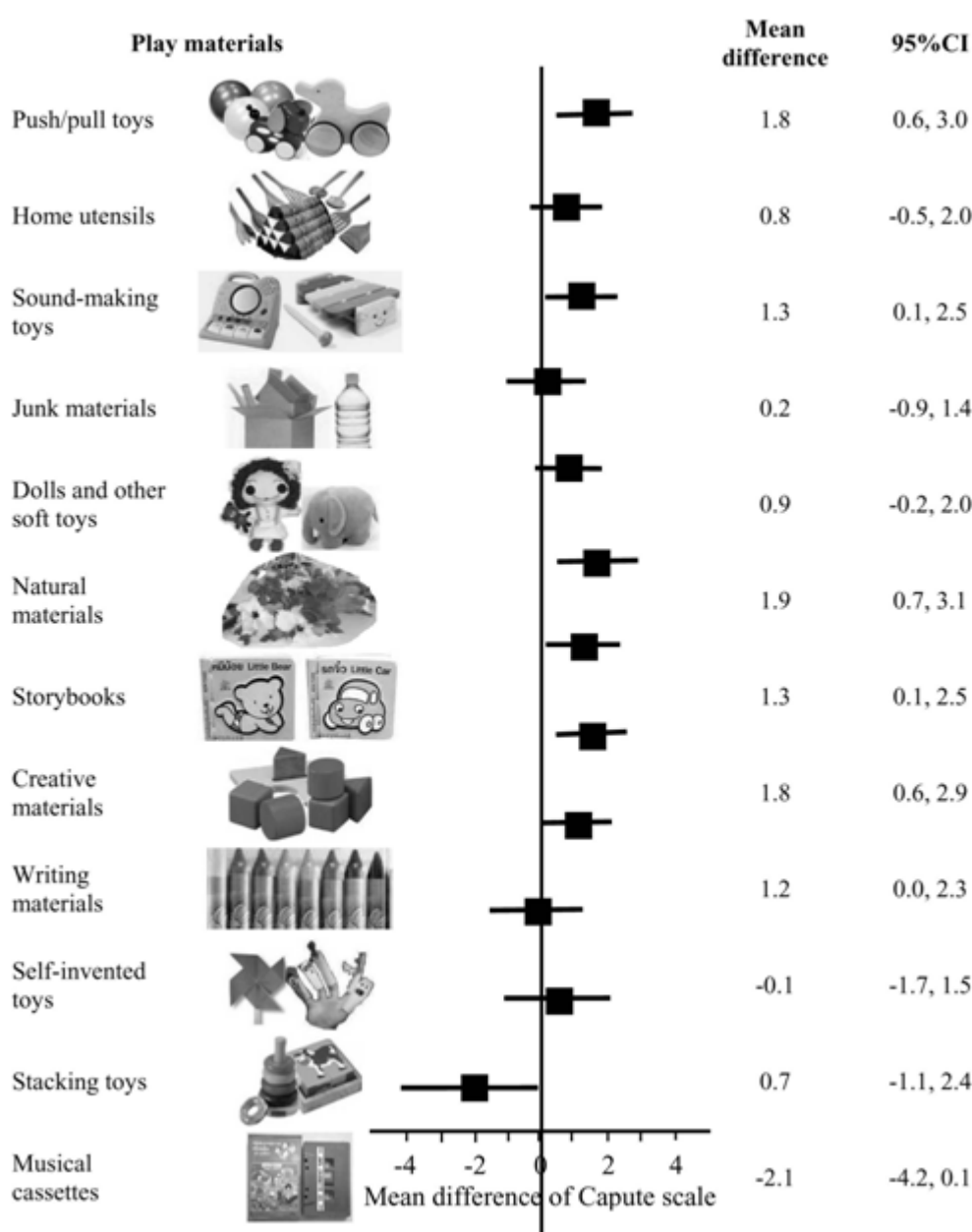


Figure 3. Multiple linear regression assessing the effects of the types of play materials on the Capute scale, adjusted for the effects of: study center, mother's age, parent's education, marital status, income, sex, weight, length, gestational age, birth weight, breastfed, hospital admission(s), mother's attachment, family size, number of siblings, iodine consumption, and life events. ($n = 2,641$; $R^2 = 34.4\%$)

Discussion

During the first year of life—when the nervous system develops—play material is a stimulation mechanism for cognitive development of infants. This large cohort study examined the role of play materials on cognitive development according to the Capute scale, measured when each child reached their first year of life. Play materials were based on what was found in each child's home (i.e., their usual setting with uncontrolled conditions) and categorized into Chase's 12 types [25]. The Capute scales were measured by trained pediatricians when each child visited the hospital, according to the schedule set by the PCTC.

Several potential confounders—mostly collected since the children were born—accounted for the effects on the association between play materials and cognitive development. Accordingly, we found that five of the 12 types of play materials were significantly associated with the Capute scale, but three (viz., natural materials, creative materials, and push/pull toys) had the strongest effect. The remaining two significant play materials had Capute scores of about 1.

To the best of our knowledge, this is the first and the largest study to assess the effects of play materials on cognitive development. The study also accounted for the largest number of confounders—about 15 factors plus the various types of play materials. Although most of the confounders were measured at birth, the play materials were recorded two weeks prior to measurements of cognitive development. This is because it is the earliest age at which cognitive development can be measured and the Capute scale was the only measurement tool available in the Thai language. Play materials found at home two weeks prior to the cognitive development measurements were considered the maximum number available for play. The number of play materials not counted should be at a minimum.

The current study found that push/pull toys, home utensils and sound-making toys were the most common materials being played with at home, which agrees with Chase's classification that push/pull toys and music toys are more suitable for children 12 months or older [25]; at which age, the children can walk steadily for short distances, and can sway and bounce to music. Home utensils (e.g., bowls, plates, spoons) can be classified as "fill and dump toys" according to Chase [25], which reflects Thai rural ways of life

where children are surrounded by these types of items. These materials make a good choice of play materials for families with limited resources but safety can become an issue when these types of materials are used for toys. Interestingly, based on the three most commonly played with materials, about three-fourths of the children played with them; this proportion was also the maximum number of children who played with toys. It would be interesting to understand why the remaining one-fourth did not play with these materials.

About 7% of the children played music cassettes and this group had a lower Capute scale than children who did not play music cassettes. Even after adjusting for the effects of many potential confounders, this material tended to be associated with a lower Capute scale although it is not statistically significant. The reason behind this is unclear, hence further investigation is required.

Like any observational study, this study could be affected by biases, in particular, a confounding bias. Although we accounted for the effects of many factors through the multivariable analysis, there might still be a number of unknown confounders. Play materials in a child's home were observed but briefly before cognitive development was investigated. This might not represent a long enough period during the six months before reaching one year of age. There are also many factors within the play material itself that remain to be considered; for instance, how the children play, for how long and with whom.

Conclusion

In fact, there was no single play material that is the best. Based on review results of many studies, Chase stated that "*The two most potent variables correlating with cognitive development during infancy and the preschool years were the availability of play materials and the quality of maternal (parental) involvement*" [25]. We added that if we were to choose them, the following play materials are advisable—natural materials, creative materials, and push/pull toys.

Acknowledgements

The PCTC was supported by the Thailand Research Fund, the Health System Research Institute of Thailand, the Ministry of Public Health of Thailand, Dumex Thailand, and World Health Organization. The authors thank the staff of the PCTC study team who collected and managed the data and Mr. Bryan

Roderick Hamman and Mrs. Janice Loewen-Hamman for English-language presentation of the manuscript. The authors had no conflict of interests.

References

- Hillemeier MM, Morgan PL, Farkas G, Maczuga SA. Perinatal and socioeconomic risk factors for variable and persistent cognitive delay at 24 and 48 months of age in a national sample. *Matern Child Health J*. 2010. [Epub ahead of print].
- Marques dos Santos L, Neves dos Santos D, Bastos AC, Assis AM, Prado MS, Barreto ML. Determinants of early cognitive development: hierarchical analysis of a longitudinal study. *Cad Saude Publica*. 2008; 24: 427-37.
- Duration and developmental timing of poverty and children's cognitive and social development from birth through third grade. *Child Dev*. 2005; 76:795-810.
- Meio MD, Lopes CS, Morsch DS. Prognostic factors for cognitive development of very low birth weight premature children. *Rev Saude Publica*. 2003; 37:311-8.
- Mackner LM, Black MM, Starr RH, Jr. Cognitive development of children in poverty with failure to thrive: a prospective study through age 6. *J Child Psychol Psychiatry*. 2003; 44:743-51.
- Cooke RW. Perinatal and postnatal factors in very preterm infants and subsequent cognitive and motor abilities. *Arch Dis Child Fetal Neonatal Ed*. 2005; 90: F60-3.
- Caravale B, Tozzi C, Albino G, Vicari S. Cognitive development in low risk preterm infants at 3-4 years of life. *Arch Dis Child Fetal Neonatal Ed*. 2005; 90: F474-9.
- Gomez-Sanchiz M, Canete R, Rodero I, Baeza JE, Gonzalez JA. Influence of breast-feeding and parental intelligence on cognitive development in the 24-month-old child. *Clin Pediatr (Phila)*. 2004; 43:753-61.
- Kramer MS, Aboud F, Mironova E, Vanilovich I, Platt RW, Matush L, et al. Breastfeeding and child cognitive development: new evidence from a large randomized trial. *Arch Gen Psychiatry*. 2008; 65:578-84.
- Charlesworth R. *Understanding child development : for adults who work with young children*. 7th ed. Australia: Thomson Delmar Learning; 2008.
- Tamis-LeMonda CS, Shannon JD, Cabrera NJ, Lamb ME. Fathers and mothers at play with their 2- and 3-year-olds: contributions to language and cognitive development. *Child Dev*. 2004; 75:1806-20.
- Avan BI, Rahbar MH, Raza SA. The role of family configuration in early childhood intellectual development in the context of an extended family system in Pakistan. *J Postgrad Med*. 2007; 53:27-33.
- Singer HS, Chiu AY, Meiri KF, Morell P, Nelson PG, Tennekoon G. Advances in understanding the development of the nervous system. *Curr Opin Neurol*. 1994; 7:153-9.
- Rathus SA. *Childhood : voyages in development*. 2nd ed. Australia: Thomason Wadsworth; 2006.
- Besio S. An Italian research project to study the play of children with motor disabilities: the first year of activity. *Disabil Rehabil*. 2002; 24:72-9.
- Tomopoulos S, Dreyer BP, Tamis-LeMonda C, Flynn V, Rovira I, Tineo W, et al. Books, toys, parent-child interaction, and development in young Latino children. *Ambul Pediatr*. 2006; 6:72-8.
- Hill PM, McCune-Nicolich L. Pretend play and patterns of cognition in Down's syndrome children. *Child Dev*. 1981; 52:611-7.
- van der Kooij R. A study of the play behavior of retarded children. *Int J Rehabil Res*. 1978; 1:329-41.
- Toth K, Munson J, Meltzoff AN, Dawson G. Early predictors of communication development in young children with autism spectrum disorder: joint attention, imitation, and toy play. *J Autism Dev Disord*. 2006; 36: 993-1005.
- DiCarlo CF, Reid DH, Stricklin SB. Increasing toy play among toddlers with multiple disabilities in an inclusive classroom: a more-to-less, child-directed intervention continuum. *Res Dev Disabil*. 2003; 24:195-209.
- Hsieh HC. Effects of ordinary and adaptive toys on pre-school children with developmental disabilities. *Res Dev Disabil*. 2008; 29:459-66.
- Gottfried AW. The relationship of play materials and parental involvement to young children's cognitive development: The contributions of play materials and parent involvement to children's development. Lexington, MA.: Lexington Books; 1986.
- Elardo R, Bradley R, Caldwell BM. The relation of infants' home environments to mental test performance from 6 to 36 months: A longitudinal analysis. *Child Development*. 1975; 46:71-6.
- Glassy D, Romano J. Selecting appropriate toys for young children: the pediatrician's role. *Pediatrics*. 2003; 111:911-3.
- Chase RA. Toys, play, and infant development. *J Perinat Educ*. 1994; 3:7-19.